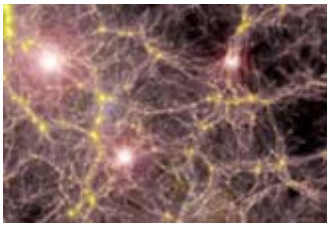

The Greatest Explosions Studies Reveal Crowded, Violent Early Universe

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A pair of new studies bolsters the long-held suspicion that the early universe was cramped and violent, with galaxies packed tight and stellar explosions greater than any that occur today.

The results indicate it was also a crucial era to the future of planets and life.

The first stars in the universe, thought to form while galaxies were still drawing together, were huge. Astronomers theorize that the universe initially contained only hydrogen and helium, with perhaps traces of lithium. With only these raw materials to work from, primordial stars would have been up to 200 times as massive as the Sun, according to theory.

Prior to this era of initial star formation, which began about 200 million years after the Big Bang, the universe was a relatively quiet place. Massive stars live short lives -- as little as 3 million years compared to our middle-aged Sun, which is already 4.6 billion years old. When they die, they do so explosively, forging new and heavier elements and shooting their production into space. Astronomers call such an event a supernova.

A new computer simulation shows just how wild things must have been back then.

"We were surprised by how violent the first supernova explosions were," said Volker Bromm of the Harvard-Smithsonian Center for Astrophysics.

Volker and his colleagues say this "greatest generation" of stars spread "incredible amounts" of heavier elements across space. These elements became the seeds of subsequent stars, as well as planets.

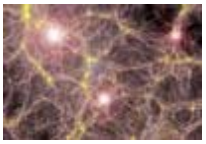
"A universe that was in a pristine state of tranquility was rapidly and irreversibly transformed by a colossal input of energy and heavy elements, setting the stage for the long cosmic evolution that eventually led to life and intelligent beings like us," Bromm said in a statement released today.

This research will be published in *Astrophysical Journal Letters*.

Each explosion, according to the simulation, shot gobs of iron -- equal to the mass of 100 Suns -- up to 3,000 light-years out into the fledgling universe.

In that universe, which had barely begun to expand from an almost infinitely dense

Images



A new simulation of the early universe shows small protogalaxies clustered together into vast filamentary structures. Within these glowing galactic building blocks, supernovae exploded like firecrackers as the first, "greatest generation" of stars rapidly used up their fuel and died.

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initial state, space was tight. Material was clumping along vast filaments, probably aided by mysterious dark matter.

Imagine the cosmos today as involving a few hundred people wandering around the streets and tunnels of Manhattan. Rewind more than 13 billion years, leave the streets and subways in place, and imagine each person represents a galaxy. When the first stars were exploding, countless small protogalaxies, each less than one-millionth the mass of the Milky Way, were "crammed together like people on a crowded subway car," Bromm's team says.

This long-held notion of compactness was supported by a new set of observations, done separately and announced yesterday.

Astronomers at the University of Edinburgh searched a region of the distant universe known to contain large elliptical galaxies. Such galaxies are thought to form from building blocks -- smaller galaxies, that have remained largely elusive.

The study looked at an area presumed to be dense based on other observations.

Near the large galaxies, the researchers found several previously unknown objects they presume to be small galaxies, or protogalaxies. These apparent companions to the larger galaxies are seen as the potential galactic building blocks astronomers have been searching for.

"The companion objects are located in the densest parts of the intergalactic medium, strung out like beads of water on a spider's web due to the filamentary structure of the universe," said Rob Ivison, a study member from the university.

The observations were made with the James Clerk Maxwell Telescope in Hawaii and are detailed in today's issue of the journal *Nature*.

The two studies, one a computer simulation and one a set of observations, dovetail nicely in how they describe the early universe.

The merger of smaller galaxies into larger galaxies -- for which the Edinburgh team has seen some evidence -- is thought to have fueled rapid star formation. The star formation drew from primordial hydrogen as well as the stuff cast off by first-generation stars that exploded, as detailed by the new simulation.

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